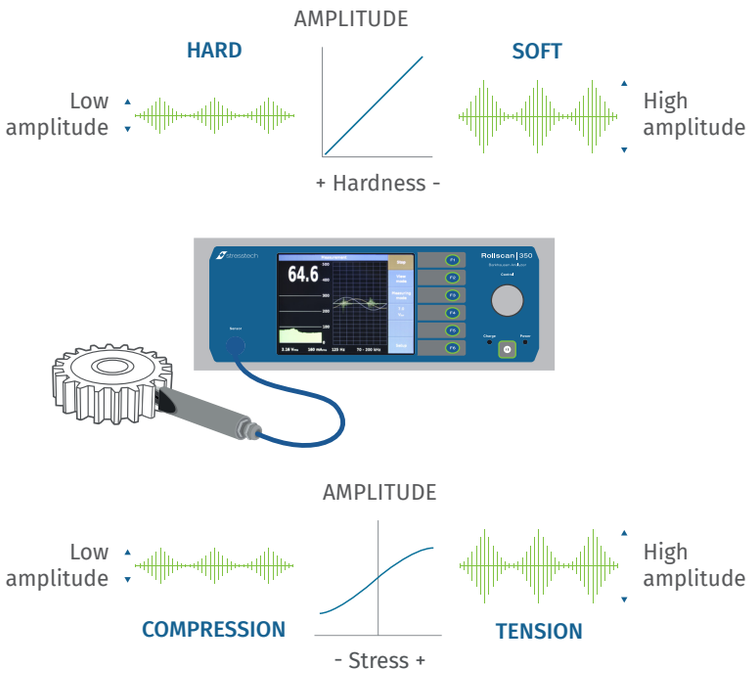
Grinding burn and heat treatment defect testing by

Barkhausen Noise Analysis

Barkhausen Noise Analysis, also known as the micromagnetic method, is based on a concept of inductive measurement of a noise-like signal generated when a magnetic field is applied to a ferromagnetic sample.



Analysis

Barkhausen Noise Analysis (BNA) also referred to as Magnetic Barkhausen Noise (MBN) is a non-destructive technique involving the inductive measurement of a noise like signal induced in a ferromagnetic material by an applied magnetic field. Continuous development of the technology and application thereof has resulted in BNA becoming a recognized and trusted non-destructive technique for materials characterization and defect detection testing.

Barkhausen Noise is directly affected by two important material characteristics, the first being the presence and distribution of residual (and applied) stresses. In most commonly used steels the Barkhausen signal will increase with the presence of tensile residual stress and decrease in the case of compressive stress states. The method is not only sensitive to stress magnitudes but direction as well. Barkhausen Noise is also affected by changes in material microstructure. This effect can be broadly described as correlation to material hardness where hardened microstructures result in lower measured values. Conversely, soft or tempered microstructures result in higher Barkhausen Noise intensities.

In most instances the analysis of the Barkhausen Noise signal can be represented as a single value, typically referred to as the magnetoelastic parameter or mp. Measurements commonly require a small sensor come in contact with or very near to the sample surface. Acquisition and processing of the signal is completed in real-time resulting in immediate feedback and the capability to meet high throughput scenarios.

Applications

- ✓ Grinding Damage Detection
- ✓ Heat Treatment Defect Detection
- ✓ Case Depth Analysis
- ✓ Residual Stress Measurement

The more common applications of the technique include the detection of grinding damage (burn) in bare and plated components as well as process verification and defect detection in heat treated parts. More recently, the method has been shown to provide accurate, non-destructive case depth analysis. Barkhausen Noise Analysis has proven to be an advantageous alternative for inspections that traditionally required time consuming and cost prohibitive semi- and completely destructive techniques.

What's the difference?
Nital Etch

Nital etch is a traditional method which relies on a subjective examination of a component surface, often requiring the operator to evaluate parts using literal shades of gray. Barkhausen Noise Analysis provides a more sensitive, objective, and repeatable real-time grinding burn inspection without requiring chemicals or consumables. It is completely non-destructive and results in substantial cost savings by reducing scrap, and eliminating the need for chemical disposal, and personal protective equipment.

What's the difference?
Eddy Current

Often compared to Barkhausen Noise, eddy current is a traditional NDT method which is optimized for detection of physical flaws such as cracks. It lacks the sensitivity to stress and microstructure, the very properties most influenced by grind and heat treatment, to which Barkhausen Noise is specifically tailored.

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APPLICATION NOTES:

Barkhausen Noise on a Landing Gear Piston

THE PROBLEM

During the manufacture and overhaul of many landing gear components, precision grinding of plated steel (i.e. hard chrome or HVOF coatings) is required. The steel substrates of these pins, axles, pistons, among others, are easily susceptible to re-temper or grinding burn during the grinding process. However, traditional techniques for grind burn detection like acid etching are not applicable to coated or plated surfaces, as the critical areas are under the coatings. Part quality must still be verified in these critical components and it has to be done by non-destructive means.

THE TESTING METHOD

Barkhausen noise is created by a ferro-magnetic material under the influence of a magnetic field and is sensitive to the changes in stress and microstructure that can occur during the grinding process. Barkhausen noise testing non-destructively measures the ferro-magnetic steel substrate through the coating. The measurements were carried out in accordance with the SAE document, ARP4462B: Barkhausen Noise Inspection for Detecting Grinding Burns in High Strength Steel Parts, which dictates the test parameters and criteria for rejection. In this case, the testing was performed semi-automatically, with the sensor traversing axially as the part was rotated for 100% coverage.



Figure 1: Photo of measured piston

THE RESULTS

Data collection software was able to automatically provide a pass/fail determination as well as generate a 'heat mapping' of the surface for identifying and locating any points of interest.

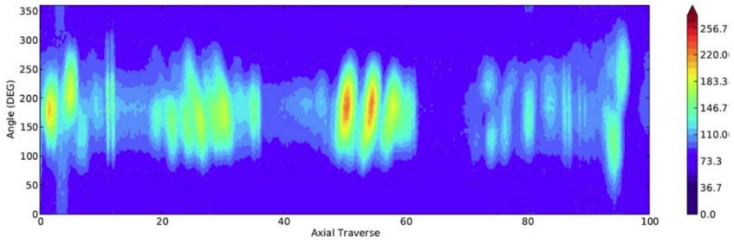


Figure 2: 3d heat map showing measured Barkhausen value vs location on a chrome plated landing gear piston

INSTRUMENTS USED FOR THIS APPLICATION:

Rollscan 350 Barkhausen noise analyzer, high output circumferential OD sensor and Viewscan software for acquisition analysis



Figure 3: Rollscan 350 Barkhausen noise analyzer